

Impact of contour hedgerows: A case study

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Preface

The International Centre for Integrated Mountain Development (ICIMOD) was established in 1983 amidst increasing concern about environmental degradation and poverty in the Hindu Kush-Himalayan (HKH) region. Its area of mandate is the Hindu Kush-Himalayan region (all or part of the eight countries Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan). ICIMOD's activities focus on the reduction of poverty and the conservation of the natural resource base.

The HKH sustains a population of about 150 million peoples of diverse cultures, the great majority of whom depend upon agriculture as their main source of livelihood. The well-being of mountain peoples is to a great extent determined by the state of mountain agriculture and the potential for economic improvement. Equally, the security of the livelihoods of future generations depends on ensuring that use of natural resources is sustainable, and that the environment is maintained and not degraded.

Mountain agriculture in the HKH is slowly transforming from traditional farming of cereal crops to mixed farming of high-value cash crops and animal husbandry for income. This agricultural transformation poses new challenges, and farmers can no longer rely solely on the wealth of indigenous knowledge acquired over generations. New choices of appropriate crops for the specific local mountain conditions, choices of appropriate methods for land use intensification without upsetting the sensitive balance of fragile mountain ecosystems, new methods of extending agricultural practices to marginal lands that stabilise rather than destroy, increasing the water supply through water harvesting and irrigation, new ways of improving crop productivity and quality without negatively affecting the environment, are technologies that must be tried, tested and integrated within existing farming systems. Many improved technologies have been developed for and promoted in mountain areas with the aim of reducing poverty and conserving the environment.

But as mountain farmers have very limited resources, they are risk adverse and will not invest in an improved technology unless they can assess it carefully first. For technologies to be adopted by farmers they must first be tested and demonstrated in an accessible and convincing way.

ICIMOD established its Demonstration and Training Centre at Godavari, on the southern slopes of the Kathmandu Valley, in March 1993, following the generous provision of 35 hectares of land by His Majesty's Government of Nepal in November 1992. The site provides a place where different technologies and (farming) practices useful for sustainable development can be tested, selected, and demonstrated; where farmers and those who work with them can be trained; and which can serve as a repository for plant germplasm resources and associated floral and faunal biodiversity. Activities in an integrated agricultural system are by their nature cross-cutting and often interactive and interdependent. The activities at the Godavari Centre are linked within a holistic approach that covers a broad range of the possibilities for livelihood – and quality of life – improvement of mountain farmers.

Over the years a large amount of information has been accumulated related to the activities at the Godavari Centre. It includes background information about technologies, species, and general approaches for integrated mountain development; results of trials and

recommendations of appropriate species and technologies; training materials; and many others. The series '**Focus on Godavari**' has been developed to provide a platform for formal publication and wider dissemination of this information. We hope that these books will prove useful to a wide audience, and help provide information that will benefit mountain farmers. We welcome feedback from our readers and new ideas for the series.

Executive Summary

Severe soil erosion and declining soil fertility are widely regarded as major problems threatening the sustainable use of sloping agricultural land in the Hindu Kush-Himalayan region. Simple terracing is widely used to control soil erosion, but it is not always effective and increasingly less so as agriculture is extended to ever more and steeper slopes in the attempt to increase production. There are few effective methods available in the region to control soil erosion and improve soil fertility simultaneously. Sloping agricultural land technology (SALT), or contour hedgerow intercropping (agroforestry) technology (CHIAT), using nitrogen-fixing plants has shown potential in tropical regions in controlling soil erosion and in improving soil fertility of sloping agricultural land. In this system, the terraces are developed by planting dense hedgerows of fast growing perennial woody tree or shrub species, usually nitrogen-fixing species, along contour lines thus creating a living barrier that traps sediments and gradually transforms the sloping land to terraced land. The hedgerows lining the terrace help improve soil fertility through nitrogen fixation at the roots and incorporation of the hedgerow trimmings into the soil. However, competition is sometimes observed between the hedgerows and the crops in the valleys; fear of this is thought to have inhibited widespread adoption of the technology by farmers in tropical regions.

Two experiments were set up at ICIMOD's Trial and Demonstration site at Godavari to investigate different aspects of SALT and its usefulness and applicability in the cooler climate of the Himalayan mid-hills. The first experiment, from 1995 to 2001, investigated the impact of hedgerows on soil erosion and soil fertility; the second, from 1998-2001, looked at the potential competition between hedgerows and crops for soil nutrients and soil moisture. The results of these experiments are described in this book: Chapter 1 provides an overview of SALT and the experimental set up at the Godavari site; Chapter 2 describes the impact of hedgerows on soil erosion; Chapter 3 the impact of hedgerows on soil fertility; Chapter 4 the extent of hedgerow-crop competition for nutrients; and Chapter 5 the extent of hedgerow-crop competition for soil moisture.

The impact of hedgerows on soil erosion and soil fertility was tested using five different treatments: one with normal farming practice without hedgerows, and four with two different hedgerow species, different cropping approaches, and with or without application of organic fertiliser for the annual crops.

Soil erosion was evaluated from sediment concentration in runoff and total runoff. The contour hedgerows were very effective in reducing soil erosion to a very low level, with a marked impact from the second year of planting and a reduction in soil loss by 80-99% from the fifth year on, suggesting that hedgerows have the potential to facilitate continuous cultivation of sloping cropland.

Soil fertility was monitored through annual collection and analysis of soil samples from a depth of 0-30 cm. The hedgerows did not improve soil fertility in the experiments with freshly planted hedgerows as evaluated in terms of parameters like organic matter and nitrogen. This was partly because the soils started with a high level of most soil nutrients in a fertile forest soil, rather than a degraded agricultural soil, and partly because of the low production of fresh biomass by the hedgerows. The hedgerows did help reduce loss of available potassium and in the long run would probably help maintain soil fertility. One type of land use management, planting of peach trees in the alleys with intercropping of vegetables, did increase the availability of several nutrients, especially available phosphorous and potassium. Hedgerow-crop competition for nutrients and soil moisture was assessed using sample sites with or without cultivation of crops in an established hedgerow alley. Soil

samples were collected at three different distances from hedgerows and analysed for soil nutrients. Soil moisture was assessed from measurements at five-day intervals of soil tension at four different depths at each of three different distances from the hedgerows. The potential competition for water between hedgerow and crop was investigated by modelling.

The results indicate that there was no competition between hedgerows and crops for soil nutrients; the soil content of most nutrients was higher closer to the hedgerows suggesting that the hedgerows actually improved the soil nutrient status. There was competition between the hedgerows and crops for soil moisture in the dry season. Interestingly, although yield of radish (the dry season crop) was higher closer to the hedgerows, yield of maize (the monsoon crop) was slightly lower, indicating that factors other than nutrient status affect crop yield, and that the effects on different crops are not uniform.

The study showed clearly that SALT can be used effectively in subtropical and temperate regions, not only in the tropical regions where it was first developed. The method can help facilitate sustainable management of sloping cropland and can contribute to sustainable mountain agricultural development and environmental conservation by reducing soil erosion and increasing productivity, opening up the possibility of continuous cultivation of sloping croplands. In order for the technology to achieve its full potential, other, possibly more appropriate, hedgerow species need to be tested, and more investigations of different crops and their yields need to be carried out to identify optimum combinations for applications in temperate and subtropical areas of the HKH.